Arsenic Treatment Technologies

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Water Technologies for Rural Texas
Tuesday, December 2, 2003

RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions

Research and Development at EPA

- 1,950 employees
- $700 million budget
- $100 million extramural research grant program
- 13 lab or research facilities across the U.S.
- Credible, relevant and timely research results and technical support that inform EPA policy decisions

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As Treatment - Overview

- As Chemistry
- Treatment Technology Review
- Current Research
- Information Available on the Web

Arsenic Chemistry

- Two primary oxidation states

As (III) As (V)

$H_3AsO_3^0$ $H_3AsO_4^0$

$H_2AsO_3^{-1}$ $H_2AsO_4^{-1}$

$HAsO_3^{-2}$ $HAsO_4^{-2}$

AsO_4^{-3}

Why is arsenic form important?

- Negative charge (pH dependent) on As(V) allows it to bind with positively charged surfaces (e.g. Fe-oxides)

- Uncharged As(III) is relatively unreactive

Coagulation/Filtration

Treatment Process	Percent Removal	
	As III	As V
Iron Coag/Filt - pH 7	55	97
Alum Coag/Filt - pH 7	18	95

Ion Exchange

Ion exchange treatment

As III - 0 percent removal

As V - 98+ percent removal

Arsenic Occurrence

Surface waters predominantly As(V)

Ground waters generally As(III), but not always

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Arsenic Treatment Technologies

- Precipitative processes
- Adsorption processes
  - Fe
  - Al
  - Mn
- Ion Exchange process
- Membrane processes
- POU/POE devices

Arsenic Treatment Technologies

Process	Mechanism	As Removal (%)
Coag./Filt.	Precipitation	95
Lime Softening	Precipitation	85
Activated Al	Sorption	90+
Fe media	Sorption	90+
Ion exchange	Ion exchange	95+
Reverse Osmosis	Filtration	90+
Nanofiltration	Filtration	65-90
Ultrafiltration	Filtration	35-75

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Arsenic Treatment-Small Systems

Small Systems Using Surface Waters

- Coagulation/filtration package plants
- Iron Removal processes - oxidation/filtration
- Lime softening package plants

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Arsenic Treatment-Small Systems

<u>Small Systems Using Ground Waters</u>

- Anion Exchange

- Activated Al or Fe media adsorption

- Iron Removal processes - oxid/filt.

Arsenic Treatment – Current Research

Laboratory Scale

As chemistry in:

- Residuals
- Distribution systems

Field Demonstrations

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Small Systems Research - Arsenic

- Field Studies: 32 sites across the USA
- www.epa.gov/ORD/NRMRL/arsenic/research.htm#round2
- Proposal deadline January 5, 2004
- Evaluate the efficiency and effectiveness of drinking water treatment technologies, process modifications and engineering approaches as well as POU/POE devices to meet the new arsenic MCL of 10 µg/l at host site locations that have varied source water quality conditions

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Arsenic Treatment – Current Research

Field Studies in Texas

Location	[As] (mg/L)	Current Treatment	Source	Pop. Served	Max. Daily Flow (gpm)
Alvin, TX	.029	PO_4 + Cl	GW	516	212
Bruni, TX	.059	Cl	GW	300	60
Wellman, TX	.039	Cl	GW	247	85

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Arsenic Publications and Information

Field Demonstration Proposals:

www.epa.gov/ORD/NRMRL/arsenic/research.htm#round2

General Information-Regulatory Issues:

www.epa.gov/safewater/arsenic.html

Publications:

www.epa.gov/ORD/NRMRL/Pubs/index.html

“Removal of Arsenic from Drinking Water by Ion Exchange Design Manual” EPA/600/R-03/080

“Small Drinking Water Systems Handbook - A Guide to "Packaged" Filtration and Disinfection Technologies with Remote Monitoring and Control Tools” EPA/600/R-03/041

“Design Manual: Removal of Arsenic from Drinking Water by Adsorptive Media” EPA/600/R-03/019

"Treatment of Arsenic Residuals from Drinking Water Removal Processes“ EPA/600/R-01/033

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Arsenic Publications and Information

Publications:

www.epa.gov/ORD/htm/ordpubs.htm (click on “Water” link)

“Arsenic Removal from Drinking Water by Coagulation/ Filtration and Lime Softening Plants” EPA/600/R-00/063

“Arsenic Removal from Drinking Water by Iron Removal Plants”
EPA/600/R-00/086

“Arsenic Removal from Drinking Water by Ion Exchange and Activated Alumina Plants” EPA/600/R-00/088

“Regulations on the Disposal of Arsenic Residuals from Drinking Water Treatment Plants” EPA/600/R-00/025

Questions?